

**BOHA-VERP Study
Resource Components**

Compendium of Results and Indicators
(DRAFT 1/21/2003)

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Project Overview and Progress (12/02)*

Initiated in October, 2000, this 3-year project aims at providing scientific input in formulating resource and social indicators and standards of quality that are pertinent to the management goals and objectives of Boston Harbor Islands National Park Area. Research activities are divided into resource and social components that are integrated to facilitate a holistic approach to implementing the Visitor Experience and Resource Protection (VERP) planning framework.

The resource component of the project focuses on identifying and developing resource-based indicators and formulating associated standards and monitoring procedures. Research activities are organized into three phases. Phase I research (10/00-09/01) focused on the analysis of park resources, identification of potential resource indicators, and selection of resource indicators. Major research activities included literature review, experts survey, unofficial trail and campsite assessments, official trail and recreation site assessments with the involvement of Earthwatch volunteers. A variety of trail- and site-based indicators were evaluated and the most appropriate indicators have been identified. The 2001 Progress Report (submitted on 11/05/02) provides more detailed account of Phase I efforts.

The first objective of Phase II research (10/01-09/02) aimed at examining groundcover and soil quality indicators with respect to their sensitivity to visitor use. Based on the recommendations of the State Archeologist, field procedures were modified to minimize ground disturbance. A series of field measurements were conducted on Georges, Peddocks and Grape Islands between June and October 2002. Quadrat-based and continuous line-transect measurements were applied within 12 circular sampling plots, six of which were indicative of high-use areas and the other six representing low-use areas. Initial measurements were conducted in June 2002, with remeasurements performed in August and October 2002, respectively. The data collected have been entered into computer and are being analyzed. Indicators selected from this year will be added to the list of selected indicators from the first-year research. Recommended standards for these selected resource indicators are being developed based on research findings and the scientific literature. Feedback from the BOHA Planning Committee will be sought. The second objective of Phase II research was to establish monitoring protocols and procedures. Specific monitoring protocols and procedures were developed for all selected indicators and are being finalized as a monitoring procedural manual. On August 12, 2002, the Principal Investigator conducted a field workshop for BOHA Planning Committee members to discuss resource indicators and demonstrate monitoring procedures.

The third and final phase of this project (10/02-12/03) is aimed at developing visitor carrying capacity guidelines for the park based on results from the first two years of research. Research findings from this component will be combined with the social-component research and will be incorporated into the BOHA carrying capacity plan. Another workshop to train park staff on field procedures is expected during the third year of the project

I. SELECTED RESULTS

A. Resource Damage on Recreation Sites

A.1 Number of Recreation Sites

Island	Type of Recreation Sites				Island Sum
	Official Picnic Sites	Official Campsites	Unofficial Sites	Rest/ Viewing Areas	
<i>Bumpkin</i>	5	13	0	3	21
<i>Button</i>	0	0	1	0	1
<i>Calf</i>	0	0	1	0	1
<i>Georges</i>	8	0	0	3	11
<i>Grape</i>	3	14	0	5	22
<i>Great Brewster</i>	7	0	0	2	9
<i>Green*</i>	0	0	0	0	0
<i>Langlee</i>	0	0	3	0	3
<i>Little Brewster</i>	2	0	0	2	4
<i>Lovells</i>	3	12	1	0	16
<i>Middle Brewster*</i>	0	0	0	0	0
<i>Outer Brewster</i>	0	0	1	0	1
<i>Pedlocks</i>	0	5	0	0	5
<i>Raccoon</i>	0	0	2	0	2
<i>Ragged</i>	0	0	1	0	1
<i>Rainsford</i>	0	0	7	0	7
<i>Sarah</i>	0	0	1	0	1
<i>Sheep*</i>	0	0	0	0	0
<i>Slate</i>	0	0	2	0	2
<i>Thompson</i>	3	5	0	0	8
<i>Webb State Park</i>	2	0	0	9	11
<i>World's End</i>	0	0	1	17	18
TOTAL	33	49	21	41	144

* These islands will be excluded from subsequent tables.

A.2 Area of Disturbance on Recreation Sites (ft²)

Island	Type of Recreation Sites								Island Sum
	Official Picnic Sites		Official Campsites		Unofficial Sites		Rest/Viewing Areas		
	Median	Sum	Median	Sum	Median	Sum	Median	Sum	
Bumpkin	1871	16051	310	9543	--	--	50	150	25744
Button	--	--	--	--	250	250	--	--	250
Calf	--	--	--	--	1087	1087	--	--	1087
Georges	17158	213166	--	--	--	--	1717	3434	216600
Grape	3900	15705	607	10839	--	--	180	1130	27674
Great Brewster	1800	17281	--	--	--	--	265	530	17811
Langlee	--	--	--	--	313	2190	--	--	2190
Little Brewster	669	1338	--	--	--	--	466	932	2270
Lovells	3584	13335	879	44098	840	840	--	--	58273
Outer Brewster	--	--	--	--	176	176	--	--	176
Peddocks	--	--	18670	110452	--	--	--	--	110452
Raccoon	--	--	--	--	366	732	--	--	732
Ragged	--	--	--	--	453	453	--	--	453
Rainsford	--	--	--	--	1157	9109	--	--	9109
Sarah	--	--	--	--	254	254	--	--	254
Slate	--	--	--	--	427	853	--	--	853
Thompson	358	1248	--	5281	--	--	--	--	6529
Webb SP	4975	9950	--	--	--	--	157	3558	13508
World's End		--	--	--	855	855	400	13344	14199
TOTAL	--	288076	--	180214	--	16798	--	23078	508,166

A.3 Soil Exposure on Recreation Sites (Percent)

Island	Type of Recreation Sites							
	<i>Official Picnic Sites</i>		<i>Official Campsites</i>		<i>Unofficial Sites</i>		<i>Rest/Viewing Areas</i>	
	Mean	Med.	Mean	Med.	Mean	Med.	Mean	Med.
<i>Bumpkin</i>	5.1	2.5	10.9	9.0	--	--	11.2	15.5
<i>Button</i>	--	--	--	--	63.0*	n/a	--	--
<i>Calf</i>	--	--	--	--	2.5*	n/a	--	--
<i>Georges</i>	13.4	15.5	--	--	--	--	2.5	2.5
<i>Grape</i>	2.5	2.5	26.6	15.5	--	--	5.1	2.5
<i>Great Brewster</i>	12.6	2.5	--	--	--	--	2.5*	n/a
<i>Langlee</i>	--	--	--	--	47.2	63.0	--	--
<i>Little Brewster</i>	20.3*	n/a	--	--	--	--	9.0*	n/a
<i>Lovells</i>	6.8	2.5	39.5	38.0	2.5*	n/a	--	--
<i>Outer Brewster</i>	--	--	--	--	15.5*	n/a	--	--
<i>Peddocks</i>	--	--	9.6	2.5	--	--	--	--
<i>Raccoon</i>	--	--	--	--	20.3*	n/a	--	--
<i>Ragged</i>	--	--	--	--	2.5*	n/a	--	--
<i>Rainsford</i>	--	--	--	--	44.9	38.0	--	--
<i>Sarah</i>	--	--	--	--	97.5*	n/a	--	--
<i>Slate</i>	--	--	--	--	38.0*	n/a	--	--
<i>Thompson</i>	50.3	38	59.9	63.0	--	--	--	--
<i>Webb SP</i>	50.5*	n/a	--	--	--	--	32.5	15.5
<i>World's End</i>	--	--	--	--	15.5*	n/a	16.9	15.5
Overall Mean/Median	16.9	2.5	27.1	15.5	36.7	38.0	16.2	2.5

* Less than 3 observations; no median values available.

A.4 Tree Damage at Recreation Sites (No.)

Island	Type of Recreation Sites						Island Sum
	Official Picnic Sites		Official Campsites		Unofficial Sites		
	Median	Sum	Median	Sum	Median	Sum	
Bumpkin	2	3	1	7	--	--	10
Button	--	--	--	--	0*	0	0
Calf	--	--	--	--	0*	0	0
Georges	2	6	--	--	--	--	6
Grape	2	2	2	11	--	--	13
Great Brewster	0	0	--	--	--	--	0
Langlee	--	--	--	--	1	2	2
Little Brewster	0*	0	--	--	--	--	0
Lovell's	0	0	2	8	2*	2	10
Outer Brewster	--	--	--	--	0*	0	0
Peddock's	--	--	0	11	--	--	11
Raccoon	--	--	--	--	1.5*	3	3
Ragged	--	--	--	--	0*	0	0
Rainsford	--	--	--	--	2	2	2
Sarah	--	--	--	--	0*	0	0
Slate	--	--	--	--	1*	1	1
Thompson	0	0	0	0	--	--	0
Webb SP	3*	3	--	--	--	--	3
World's End	--	--	--	--	2*	2	2
TOTAL	--	14	--	37	--	12	63

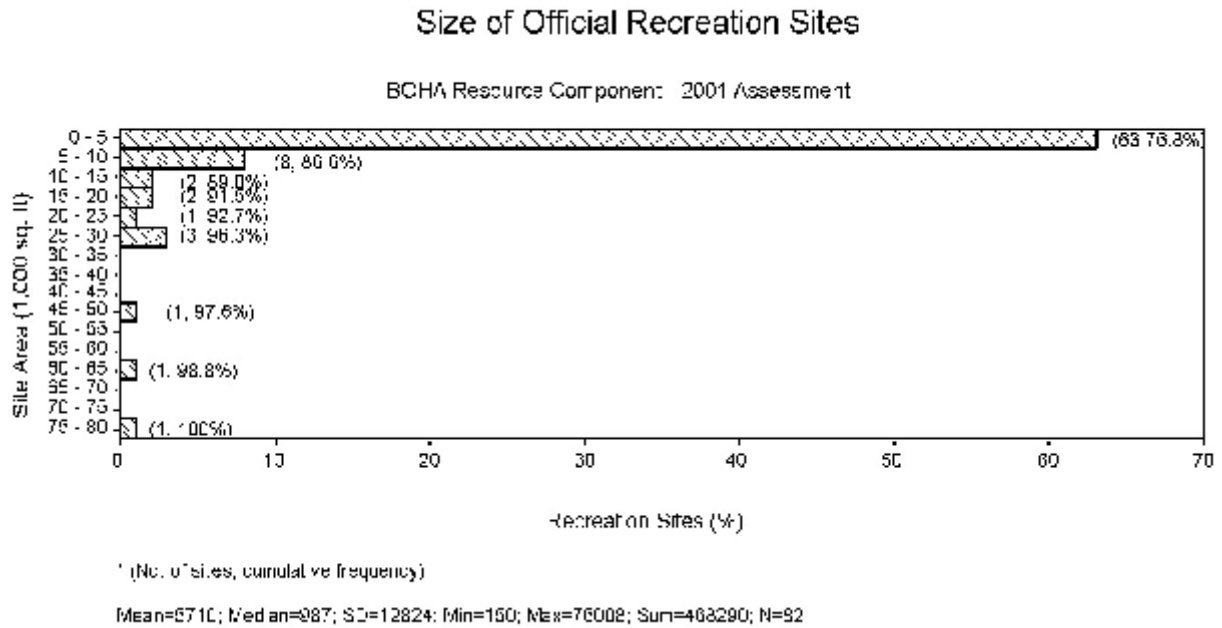
* Less than 3 observations; no median values available.

A.5 Spatial Proximity Indicator – Unofficial Recreation Sites

Total number of unofficial recreation sites that exist within 50 or 100 m of any known location of RTE plant or animal species (figures in meters)

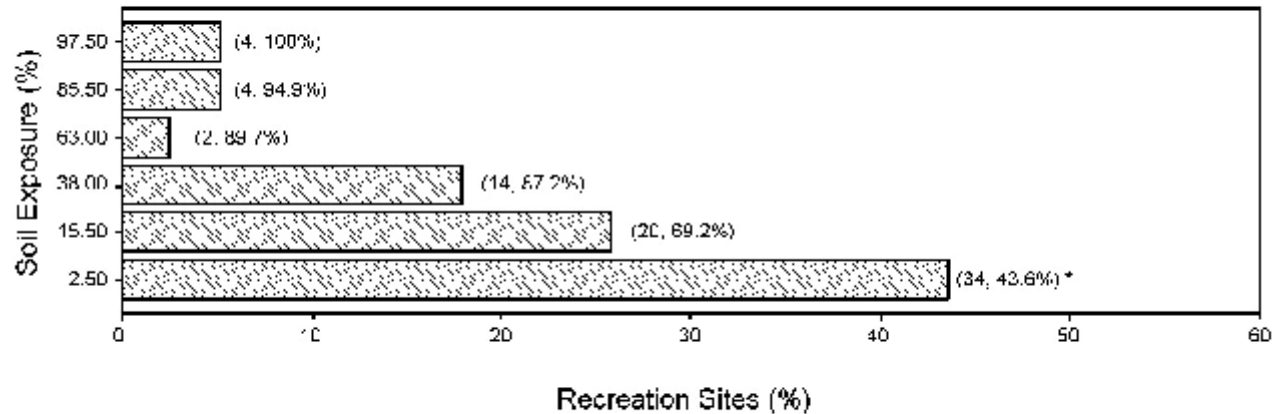
Island	50-meter Buffer	100-meter Buffer	Species Affected
Bumpkin	2	9	Seabeach dock
Georges	0	1	Barn owl
Langlee	0	1	American Sea-blite
Lovells	1	5	Least tern
Rainsford	0	1	Least tern

A.6 Diagrams Showing Distribution of Assessment Data on Official and Unofficial Recreation Sites (Site Size, Soil Exposure and Tree Damage)



Soil Exposure on Official Recreation Sites

BOHA Resource Component - 2001 Assessment

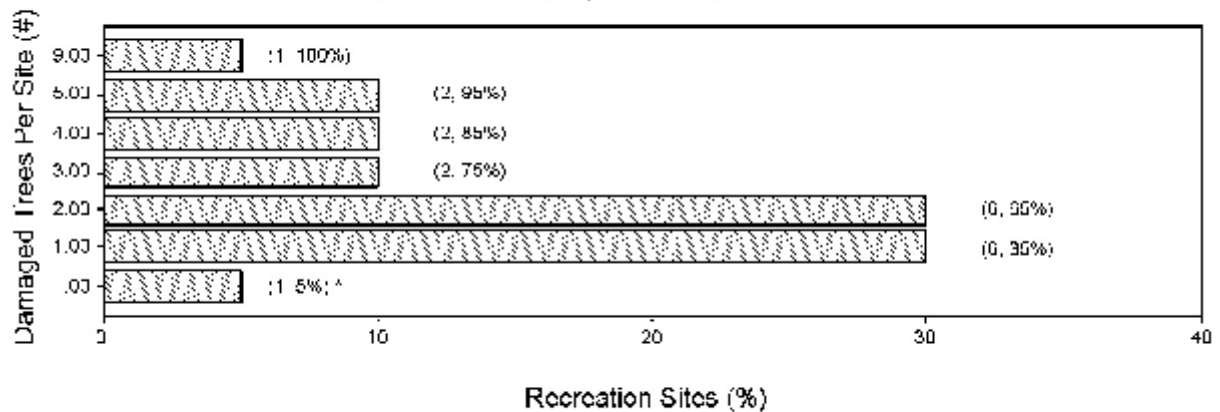


* (No. of sites, cumulative frequency)

Mean=22.9; Median=15.5; S.D.=27.8; Min.=2.5; Max.=97.5; N=78

Tree Damage at Official Recreation Sites

BOHA Resource Component - 2001 Assessment

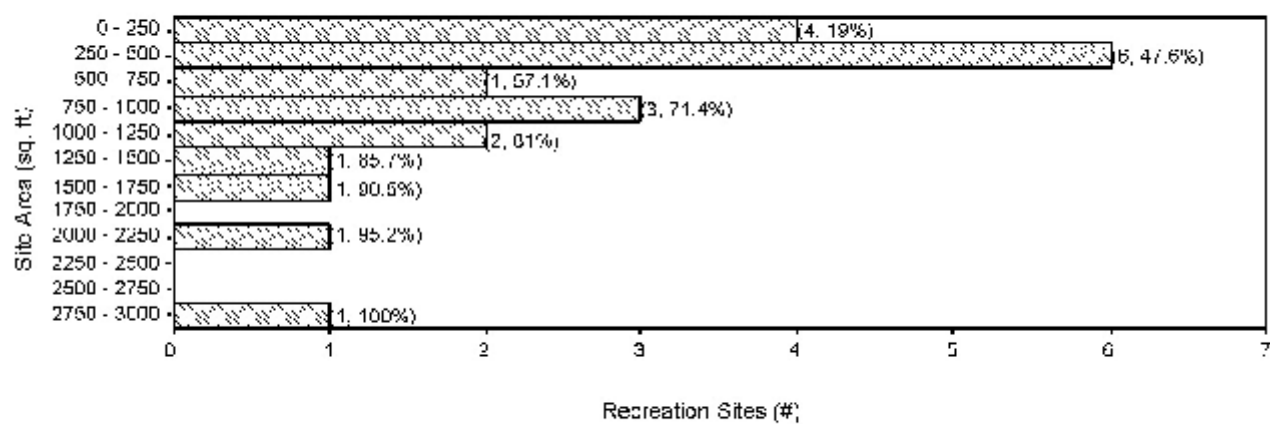


* (No. of sites, cumulative frequency)

Mean=2.8; Median=2; S.D.=2.1; Min.=0; Max.=9; Sum=51; N=50

Size of Unofficial Recreation Sites

BOHA Resource Component - 2001 Assessment

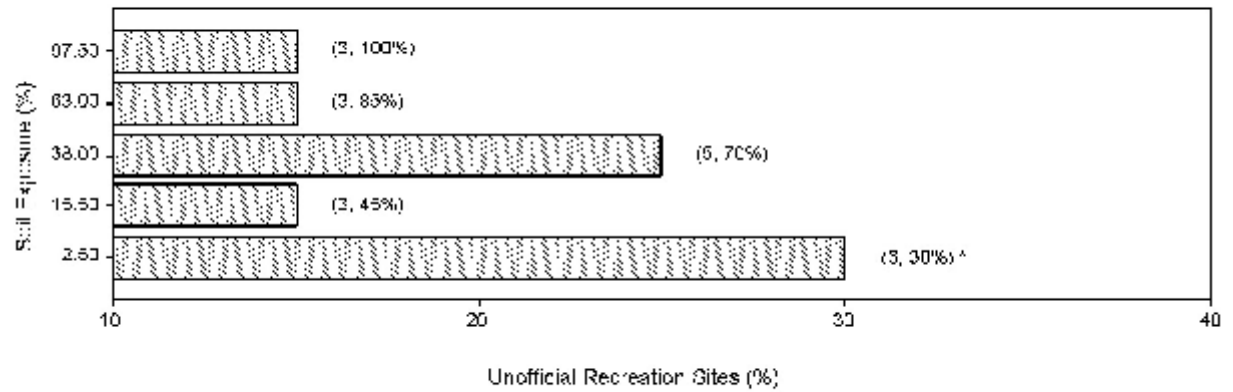


* (No. of sites; cumulative frequency)

Mean=799.9; Median=533.9; SD=718.8; Min=176; Max=2553; Sum=16798.8; N=21

Soil Exposure on Unofficial Recreation Sites

BOHA Resource Component - 2001 Assessment

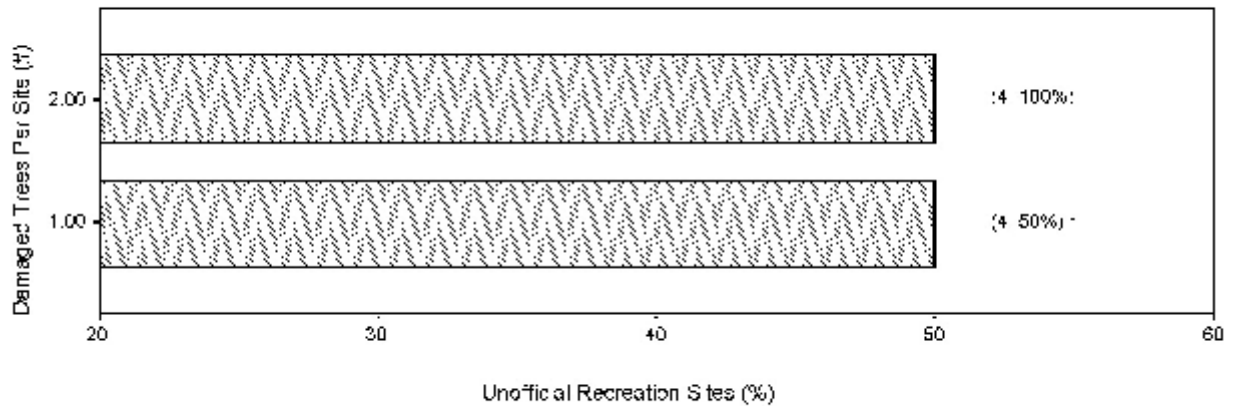


^ (No. of sites; cumulative frequency)

Mean=36.7; Median=38; SD=33.7; Min=2.5; Max=97.5; N=23

Tree Damage at Unofficial Recreation Sites

BOHA Resource Component - 2001 Assessment



^ (No. of sites; cumulative frequency)

Mean=1.5; Median=1; SD=0.5; Min=0; Max=2; Sum=12; N=8

B. Resource Degradation on Official Trails

B.1 Overall Results

Trail Tread Problem	No. of Occurrences	Length of Problem Segments (ft)				
		<i>Mean</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Std. Dev.</i>	<i>Sum</i>
<i>Bare Patches</i>	5	39.2	8	72	27.4	196
<i>Soil Erosion</i>	10	63.7	5.0	204	58.2	637
<i>Root Exposure</i>	10	35.6	18	70	20.0	356
<i>Wet Muddy Tread</i>	12	15.0	5	24	6.3	180

B.2 Results by Island

Island	Length of Trails Assessed (ft)	Bare Patches		Soil Erosion		Root Exposure		Wet Muddy Tread	
		<i>Sum (ft)</i>	<i>ft/mile</i>	<i>Sum (ft)</i>	<i>ft/mile</i>	<i>Sum (ft)</i>	<i>ft/mile</i>	<i>Sum (ft)</i>	<i>ft/mile</i>
<i>Grape</i>	7618	0	0	0	0	0	0	0	0
<i>Great Brewster</i>	2603	196	398	5	10	0	0	24	49
<i>Peddocks</i>	8474	0	0	10	6	0	0	0	0
<i>Thompson</i>	9849	0	0	173	93	0	0	96	51
<i>Webb SP</i>	5576	0	0	204	194	0	0	53	50
<i>World's End</i>	24721	0	0	418	89	356	76	7	2

C. Social Trails

C.1 Extent and Density of Social Trails by Island.

Island	Area (acre)	Social Trails	
		<i>Total Length (ft)</i>	<i>Density (ft/acre)</i>
<i>Bumpkin</i>	32.7	1142	34.9
<i>Calf</i>	22.4	3121	139.3
<i>Georges</i>	41.3	9517	230.4
<i>Grape</i>	53.7	2148	40.0
<i>Langlee</i>	5.2	878	168.8
<i>Lovells</i>	51.9	1620	31.2
<i>Outer Brewster</i>	20.1	1673	83.2
<i>Peddocks</i>	210.4	7184	34.1
<i>Racoon</i>	3.6	736	204.4
<i>Rainsford</i>	21.6	597	27.6
<i>Slate</i>	12.7	1610	126.8
<i>Thompson</i>	169.9	4241	25.0
<i>Webb SP</i>	25.3	1403	55.5
<i>World's End</i>	274.3	4254	15.5

C.2 Spatial Proximity Indicator - Social Trails

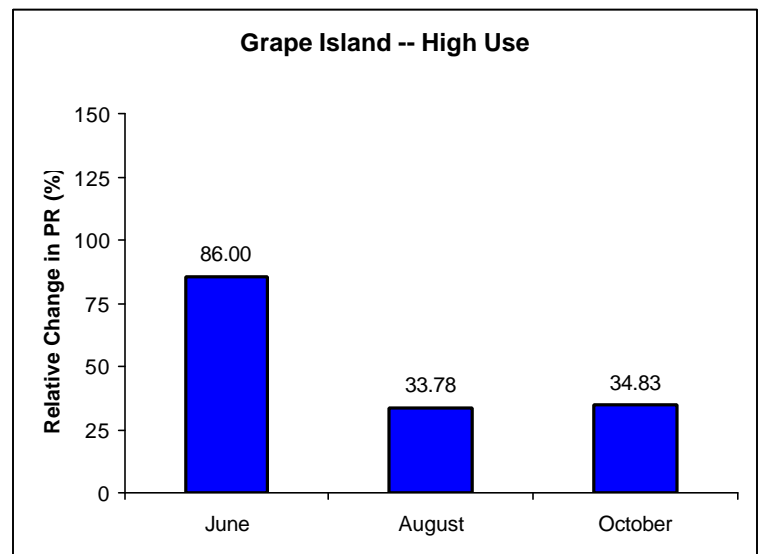
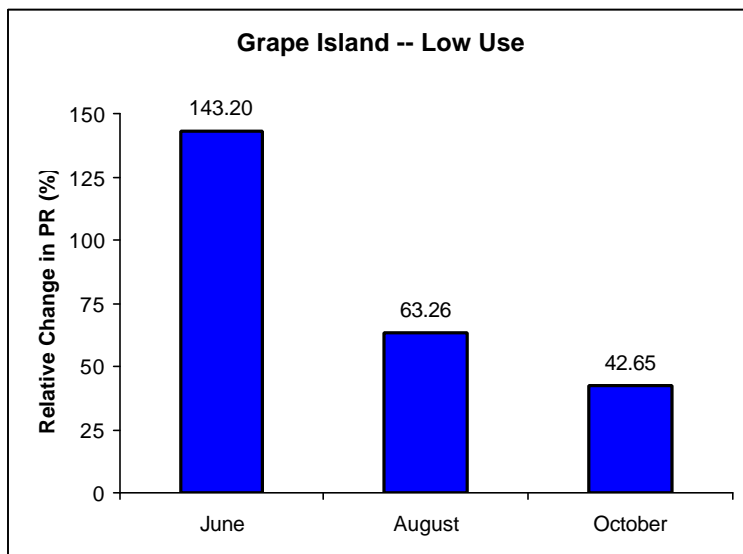
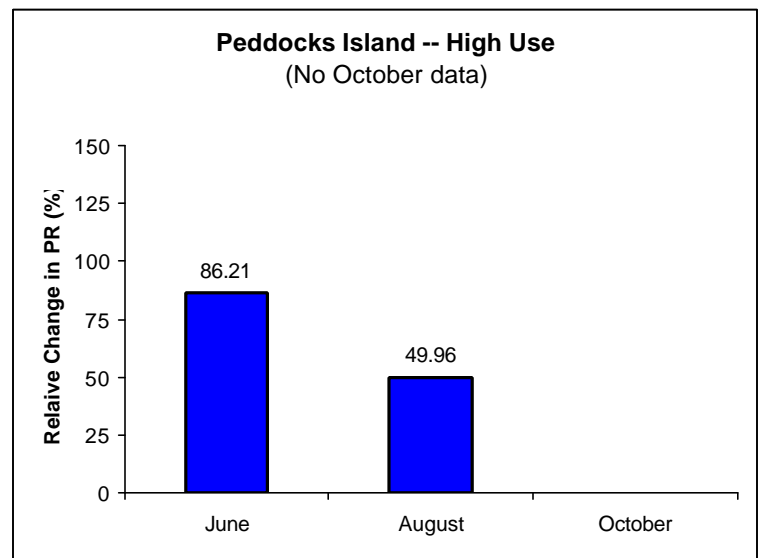
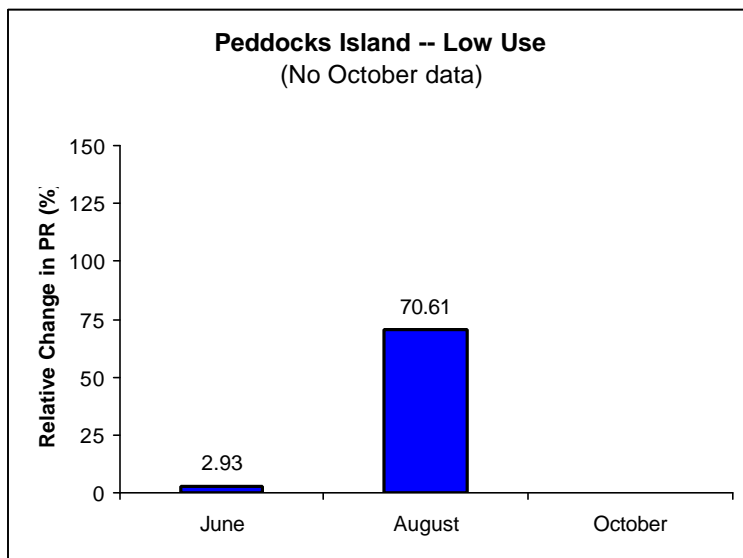
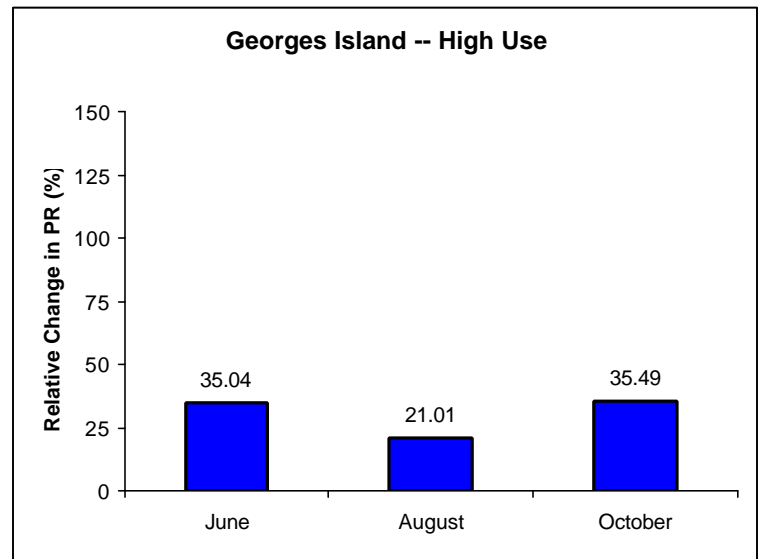
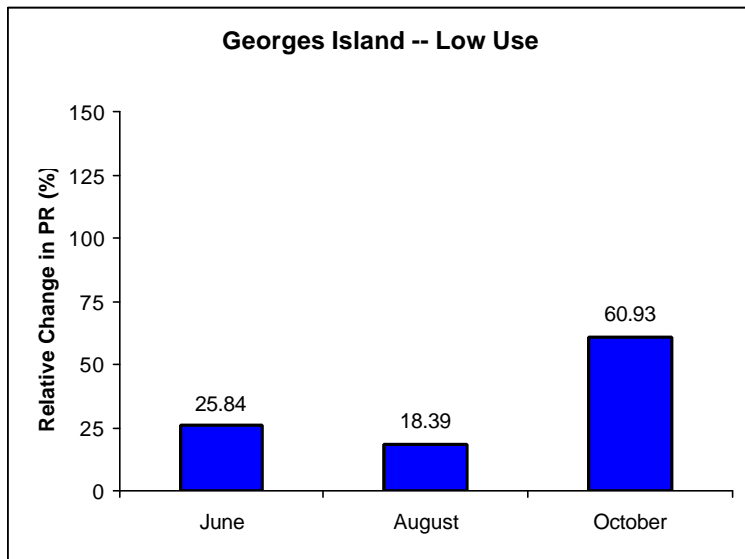
Total length of social trails that exist within 50 or 100 m of any known location of RTE plant or animal species (figures in meters)

Island	50-meter Buffer	100-meter Buffer	Species Affected
Bumpkin	13.2	13.2	Seabeach dock
Georges	26.2	135.7	Barn owl
Lovells	101.4	259.0	Least tern
Rainsford	0	260.4	Least tern
Thompson	0	21.9	Seabeach dock

Relative Change* in Penetration Resistance (PR) by Island, Month, and Use Level

BOHA Resource Component – 2002 Season

(* Based on on-site and control PR values as measured by a pocket penetrometer)



II. List of Evaluated Indicators

Types of Resources	Potential Indicators	Selected Indicators
<i>General Land Resources</i>	<ul style="list-style-type: none"> - Vegetative groundcover change - Bare patches - Mineral soil exposure - <i>Soil compaction measured by penetration resistance (on and off use area)</i> (2 types of penetrometer) - Soil aggregate stability measured by slake test 	<ul style="list-style-type: none"> - Relative change in soil compaction - Soil exposure
<i>Unofficial Recreation Sites</i>	<ul style="list-style-type: none"> - Number of sites - <i>Area of disturbance (site size)</i> - Condition class - Vegetative groundcover change - <i>Mineral Soil exposure</i> - Tree stumps or cut trees - <i>Tree damage (trunk)</i> - Social trails radiating from site - Trash/litter - Human waste - Vandalism (occurrence, type, location, extent, loss of functionality) - Spatial proximity indicator: total number of unofficial sites falling within ecologically sensitive zones 	** AREA OF DISTURBANCE (SITE SIZE) <ul style="list-style-type: none"> - Soil exposure - Tree damage
<i>Unofficial/ Social Trails</i>	<ul style="list-style-type: none"> - Sum of length - Number of trail branching points - <i>Density: Length/island area</i> - Condition class rating - Length in poor condition classes (3-4) - Social trail index (combining length and condition class) - Spatial proximity indicator: Total length of social trails falling within ecologically sensitive zones 	** DENSITY OF SOCIAL TRAIL (LENGTH PER ISLAND AREA IN FT/ACRE)
<i>Official Recreation Sites</i>	<ul style="list-style-type: none"> - Number of sites - Area of disturbance (site size) - Condition class - Vegetative groundcover change - <i>Mineral Soil exposure</i> - Tree stumps or cut trees - Tree damage (trunk) - Social trails radiating from site - Trash - Human waste - Vandalism on and around site (occurrence, type, location, extent, loss of function) - Spatial proximity indicator: Total number of sites falling within ecologically sensitive zones 	** SOIL EXPOSURE <ul style="list-style-type: none"> - Tree damage

<i>Rest/Viewing Areas or Overlooks</i>	<ul style="list-style-type: none"> - Number of sites - Area of disturbance (site size) - Condition class - Vegetative groundcover onsite - Mineral Soil exposure - Trash - Human waste - Vandalism on and around site (occurrence, type, location, extent, loss of function) - Spatial proximity indicator: Total number of sites falling within ecologically sensitive zones 	- Soil exposure
<i>Official Trails</i>	<ul style="list-style-type: none"> - Sum of length - Density: Length/island area - Bare patches (unpaved trails only) - <i>Soil erosion (unpaved trails only)</i> - Tree root exposure (unpaved trails only) - Wet soil (unpaved trails only) - Running water on trail tread - Multiple parallel treads - Pavement condition rating (paved trails only) - Vandalism along trail corridor (occurrence, type, location, extent, loss of function) - Spatial proximity indicator: Total length of official trails falling within ecologically sensitive zones 	- Soil erosion (unpaved trails only)

** Final recommendation for BOHA-VERP implementation.

Table 1. Evaluation Matrix of Potential Resource-based Indicators.

SELECTION CRITERIA*	POTENTIAL RESOURCE INDICATORS											
	Social trails		Trail conditions	Unofficial Rec. sites	Rec. site conditions	Proximity to sensitive resources	Groundcover composition		Soil Quality		Human litter (trash)	Vandalism
	Extent/density	Distribution					Vegetative	Bare soil	Compaction	Aggregate stability		
Low measurement impacts	+	+	+	+	+	+	+	+	+	+	+	+
Reliable/Repeatable	+	+	+	+	+	+	+	+	+	+	0	0
Correlation with use	+	+	+	+	+	0	+	+	+	-	+	+
Ecologically or socially relevant	+	+	+	+	+	+	+	+	+	+	0	0
Respond to impacts	+	+	+	+	+	+	+	+	+	+	+	?
Respond to management	0	0	+	+	+	+	+	+	+	+	+	+
Easy to measure	+	0	+	+	+	0	+	+	+	+	0	-
Low natural variability	+	+	+	+	+	+	-	0	0	0	?	n.a.
Large sampling window	+	+	+	+	+	+	+	+	+	+	+	+
Cost effective	0	0	0	0	0	0	+	+	+	+	+	+
Easy to train for monitoring	0	0	+	+	+	0	+	+	+	+	0	0
Baseline data	0	0	+	0	+	+	-	-	-	-	-	-
Response over different conditions	+	+	0	+	0	?	+	+	+	+	-	-
Recommended for BOHA-VERP implementation**	✓✓	?	✓	✓✓	✓✓	?	×8	✓	✓	×8	×8	×8

* The first 4 criteria are required while the other 9 are desirable criteria. These criteria were adapted from previous VERP studies (Belnap, 1998; Greater Yellowstone Winter Visitor Use Management Working Group, 1999).

+ = criterion satisfied 0 = criterion partially satisfied (or varies by zone/area) - = criterion not satisfied ? = questionable/undecided
n.a. = not applicable

× 8 = not recommended ✓ = recommended ✓✓ = highly recommended ? = questionable/undecided

Revised 1/21/2003

ISLAND	RECOMMENDED RESOURCE INDICATORS					
	Density of Social Trails (ft/acre)	Area Disturbed by <i>Unofficial</i> Recreation Sites (sq ft)	Bare Soil Exposure on Recreation Sites (%)	Eroded Tread Surface on Unpaved <i>Official</i> Trails (ft/mile)**	Tree Damage at Recreation Sites (mean # damaged trees per site)	Relative Soil Compaction on <i>Official</i> Campsites (%)
<i>Bumpkin*</i>	X	X	X		X	X
<i>Button</i>	X	X				
<i>Calf</i>	X	X				
<i>Georges*</i>	X	X	X		X	X
<i>Grape</i>	X	X	X	X	X	X
<i>Great Brewster*</i>	X	X	X	X	X	
<i>Green</i>	X	X				
<i>Langlee</i>	X	X				
<i>Little Brewster*</i>	X	X				
<i>Little Calf</i>	X	X				
<i>Lovells*</i>	X	X	X		X	X
<i>Middle Brewster</i>	X	X				
<i>Outer Brewster</i>	X	X				
<i>Peddocks*</i>	X	X	X	X	X	X
<i>Raccoon</i>	X	X				
<i>Ragged</i>	X	X				
<i>Rainsford</i>	X	X	X		X	
<i>Sarah</i>	X	X				
<i>Sheep</i>	X	X				
<i>Slate</i>	X	X				
<i>Thompson*</i>	X	X		X		
<i>Webb State Park*</i>	X	X		X		
<i>World's End*</i>	X	X		X		

* Island (and peninsula) with current public access.

** Indicators in shade were selected in the first round and were excluded from the final consideration.

SECTION I -- BY INDICATOR

Density of Social Trails

Unit of Measure: Amount of Social Trails Per Unit Island Area (ft/acre)

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	34.9	0	139.3	230.4	40.0	0	0	168.8	0
Max. Standard	10	0	0	50	10	0	0	0	0
Min. Standard	50	10	10	500	50	10	0	10	0
Probabilistic Standard	--	--	--	--	--	--	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah
Current Conditions	0	31.2	0	83.2	34.1	204.4	0	27.6	0
Max. Standard	0	10	0	0	10	0	0	0	0
Min. Standard	0	50	0	10	50	10	0	10	0
Probabilistic Standard	--	--	--	--	--	--	--	--	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	0	126.8	25.0	55.5	15.5
Max. Standard	0	0	10	50	10
Min. Standard	0	10	50	500	50
Probabilistic Standard	--	--	--	--	--

Area Disturbed by *Unofficial* Recreation Sites

Unit of Measure: Sum of recreation site sizes (Square feet)

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	0	250	1087	0	0	0	0	2190	0
Max. Standard	0	0	0	0	0	0	0	0	0
Min. Standard	0	250	250	0	0	0	0	500	0
Probabilistic Standard	--	--	--	--	--	--	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah
Current Conditions	0	840	0	176	0	732	452	9109	254
Max. Standard	0	0	0	0	0	0	0	0	0
Min. Standard	0	500	0	176	0	500	452	1000	254
Probabilistic Standard	--	--	--	--	--	--	--	--	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	0	853	0	0	855
Max. Standard	0	0	0	0	0
Min. Standard	0	500	0	0	0
Probabilistic Standard	--	--	--	--	--

Bare Soil Exposure on Recreation Sites

Unit of Measure: Mean percent exposed mineral soil on recreation site.

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	9.2 (2.5)*	63**	2.5**	13.4 (15.5)	23.6 (15.5)	12.6 (2.5)	--	47.2 (63.0)	20.3**
Max. Standard	<10	--	--	<10	<10	<10	--	--	--
Min. Standard	<30	--	--	<50	<30	<30	--	--	--
Probabilistic Standard	<10% sites >16%	--	--	<10% sites >38%	<10% sites >16%	<10% sites >16%	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Racco on	Ragged	Rainsford	Sarah
Current Conditions	--	29.9 (15.5)	--	15.5**	9.6 (2.5)	20.3**	2.5**	44.9 (38.0)	97.5**
Max. Standard	--	<10	--	--	<10	--	--	<10	--
Min. Standard	--	<30	--	--	<30	--	--	<30	--
Probabilistic Standard	--	<10% sites >16%	--	--	<10% sites >16%	--	--	<10% sites >16%	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	--	38**	56.3 (56.5)	50.5**	15.5**
Max. Standard	--	--	<10	--	--
Min. Standard	--	--	<30	--	--
Probabilistic Standard	--	--	<10% site >38%	--	--

* Median in parenthesis; ** Less than 3 observations, no mean or median value available.

Eroded Tread Surface on Unpaved *Official* Trails

Unit of Measure: Length of eroded trail segments per trail mile (ft/mile)

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	--	--	--	--	0	10	--	--	--
Max. Standard	--	--	--	--	0	0	--	--	--
Min. Standard	--	--	--	--	50	50	--	--	--
Probabilistic Standard	--	--	--	--	<10% trails >10 ft/mile	<10% trails >10 ft/mile	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah
Current Conditions	--	--	--	--	6	--	--	--	--
Max. Standard	--	--	--	--	0	--	--	--	--
Min. Standard	--	--	--	--	50	--	--	--	--
Probabilistic Standard	--	--	--	--	<10% trails >10 ft/mile	--	--	--	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	--	--	93	194	89
Max. Standard	--	--	0	0	0
Min. Standard	--	--	100	100	100
Probabilistic Standard	--	--	<10% trails >20 ft/mile	<10% trails >20 ft/mile	<10% trails >20 ft/mile

Tree Damage at Recreation Sites

Unit of Measure: Median number of trees that are severely or moderately damaged by visitors per site.

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	1	0	0	2	2	0	--	1	0
Max. Standard	0	--	--	0	0	0	--	--	--
Min. Standard	1	--	--	2	1	1	--	--	--
Probabilistic Standard	<10% site > 1 trees	--	--	<10% site > 2 trees	<10% site > 1 trees	<10% site > 1 trees	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah
Current Conditions	--	2	--	0	5	2	0	2	0
Max. Standard	--	0	--	--	0	--	--	0	--
Min. Standard	--	1	--	--	2	--	--	1	--
Probabilistic Standard	--	<10% site > 1 trees	--	--	<10% site > 1 trees	--	--	<10% site > 1 trees	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	--	1	0	3	2
Max. Standard	--	--	--	--	--
Min. Standard	--	--	--	--	--
Probabilistic Standard	--	--	--	--	--

Relative Soil Compaction on *Official* Recreation Sites

Unit of Measure: Mean Percent Change in Penetration Resistance Between On-Site and Off-Site Areas (Peak Use Season)

Conditions/ Standards	Bumpkin	Button	Calf	Georges	Grape	Great Brewster	Green	Langlee	Little Brewster
Current Conditions	N/A	--	--	51.5 (± 9.3 ; 1SE)	39.0 (± 5.0 ; 1SE)	--	--	--	--
Max. Standard	<20	--	--	<20	<20	--	--	--	--
Min. Standard	<50	--	--	<50	<50	--	--	--	--
Probabilistic Standard	<10% sites > 50%	--	--	<10% sites > 50%	<10% sites > 50%	--	--	--	--

Conditions/ Standards	Little Calf	Lovells	Middle Brewster	Outer Brewster	Peddocks	Raccoon	Ragged	Rainsford	Sarah
Current Conditions	--	N/A	--	--	29.9 (± 7.9 ; 1SE)	--	--	--	--
Max. Standard	--	<20	--	--	<20	--	--	--	--
Min. Standard	--	<50	--	--	<50	--	--	--	--
Probabilistic Standard	--	<10% sites > 50%	--	--	<10% sites > 50%	--	--	--	--

Conditions/ Standards	Sheep	Slate	Thompson	Webb State Park	World's End
Current Conditions	--	--	--	--	--
Max. Standard	--	--	--	--	--
Min. Standard	--	--	--	--	--
Probabilistic Standard	--	--	--	--	--

SECTION II -- BY ISLAND

Bumpkin

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	34.9	0	9.2 (2.5)*	--	1	N/A
Max. Standard	10	0	< 10	--	0	< 20
Min. Standard	50	0	< 30	--	1	< 50
Probabilistic Standard	--	--	< 10% sites > 16%	--	< 10% sites > 1 trees	< 10 % sites > 50%

* Median value in parenthesis

Button

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	250	63**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	10	250	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Calf

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	139.3	1087	2.5**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	50	250	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Georges

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	230.4	0	13.4 (15.5)*	--	2	51.5 (±9.3; 1SE)
Max. Standard	50	0	<10	--	0	< 20
Min. Standard	500	0	<50	--	2	< 50
Probabilistic Standard	--	--	<10% sites > 38%	--	< 10% sites > 2 trees	< 10% sites > 50%

* Median value in parenthesis

Grape

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	40.0	0	23.6 (15.5)*	0	2	39.0 (± 5.0 ; 1SE)
Max. Standard	10	0	<10	0	0	<20
Min. Standard	50	0	<30	50	1	<50
Probabilistic Standard	--	--	<10% sites > 16%	<10% trails >10 ft/mile	<10% sites > 1 trees	<10% sites > 50%

* Median value in parenthesis

Great Brewster

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	12.6 (2.5)*	10	0	--
Max. Standard	0	0	<10	0	0	--
Min. Standard	10	0	<30	50	1	--
Probabilistic Standard	--	--	<10% sites > 16%	<10% trails >10 ft/mile	< 10 sites > 1 trees	--

* Median value in parenthesis

Green

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	--	--	--	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	0	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

Langlee

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	168.8	2190	47.2 (63.0)*	--	1	--
Max. Standard	0	0	--	--	--	--
Min. Standard	10	500	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

* Median value in parenthesis

Little Brewster

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	20.3**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	0	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Little Calf

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	--	--	--	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	0	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

Lovells

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	31.2	840	29.9 (15.5)*	--	2	N/A
Max. Standard	10	0	<10	--	0	<20
Min. Standard	50	500	<30	--	1	<50
Probabilistic Standard	--	--	<10% sites > 16%	--	<10% sites > 1 trees	<10% sites > 50%

* Median value in parenthesis

Middle Brewster

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	--	--	--	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	0	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

Outer Brewster

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	83.2	176	15.5**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	10	176	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Peddocks

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	34.1	0	9.6 (2.5)*	6	5	29.9 (± 7.9 ; 1SE)
Max. Standard	10	0	<10	0	0	<20
Min. Standard	50	0	<30	50	2	<50
Probabilistic Standard	--	--	<10% sites >16%	<10% trails >10 ft/mile	<10% sites > 1 trees	<10% sites > 50%

* Median value in parenthesis

Raccoon

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	204.4	732	20.3**	--	2	--
Max. Standard	0	0	--	--	--	--
Min. Standard	10	500	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Ragged

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	452	2.5**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	452	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Rainsford

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	27.6	9109	44.9 (38.0)*	--	2	--
Max. Standard	0	0	<10	--	0	--
Min. Standard	10	1000	<30	--	1	--
Probabilistic Standard	--	--	<10% sites >16%	--	<10% sites > 1 trees	--

* Median value in parenthesis

Sarah

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	254	97.5**	--	0	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	254	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Sheep

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	0	0	--	--	--	--
Max. Standard	0	0	--	--	--	--
Min. Standard	0	0	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

Slate

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	126.8	853	38**	--	1	--
Max. Standard	0	0	--	--	--	--
Min. Standard	10	500	--	--	--	--
Probabilistic Standard	--	--	--	--	--	--

** Less than 3 observations; no mean or median value available

Thompson

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	25.0	0	56.3 (56.5)*	93	0	--
Max. Standard	10	0	<10	0	--	--
Min. Standard	50	0	<30	100	--	--
Probabilistic Standard	--	--	<10% sites > 38%	<10% trails >20 ft/mile	--	--

* Median value in parenthesis

Webb State Park

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	55.5	0	50.5**	194	3	--
Max. Standard	50	0	--	0	--	--
Min. Standard	500	0	--	100	--	--
Probabilistic Standard	--	--	--	<10% trails >20 ft/mile	--	--

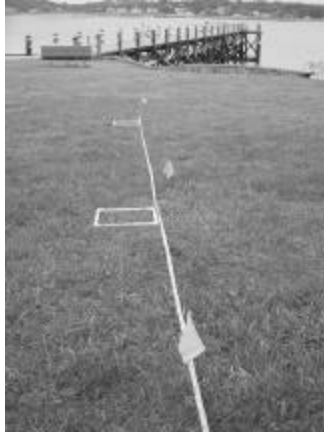
** Less than 3 observations; no mean or median value available

World's End

Conditions/ Standards	Density of social trails (ft/acre)	Area disturbed by unofficial recreation sites (sq ft)	Bare soil exposure on recreation sites (%)	Eroded tread surface on unpaved official trails (ft/mile)	Damaged trees at recreation sites (#/site)	Relative soil compaction on official recreation sites (%)
Current Conditions	15.5	855	15.5**	89	2	--
Max. Standard	10	0	--	0	--	--
Min. Standard	50	0	--	100	--	--
Probabilistic Standard	--	--	--	<10% trails >20 ft/mile	--	--

** Less than 3 observations; no mean or median value available

BOHA-VERP Study – Resource Component Field Assessment, Indicators and Standards



Yu-Fai Leung
*Parks, Recreation &
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Updated 1/21/03

Objectives of Presentation

- ◆ Overview of research efforts
- ◆ Indicator selection
- ◆ Considerations for standards

2001-2002 Research Efforts

- ◆ Analyze park resources
- ◆ Identify potential resource indicators
- ◆ Develop assessment and monitoring procedures for potential indicators
- ◆ Field assessment of recreation site, trail, vegetation and soil indicators
- ◆ Integration with BOHA GIS databases
- ◆ List of recommended indicators

Sources of Resource Indicators

- ◆ Park staff
- ◆ Field observations
- ◆ Scientific and management literature
- ◆ Previous VERP implementations
- ◆ Local experts survey
- ◆ Visitor survey results (by UVM)
- ◆ BOHA GIS databases

Field Work in Summer 2001

- ◆ June 26 to August 11, 2001
- ◆ Supported by the Earthwatch Institute
- ◆ 26 EW volunteers were trained and involved in data collection (both components)



Indicators of Resource Quality

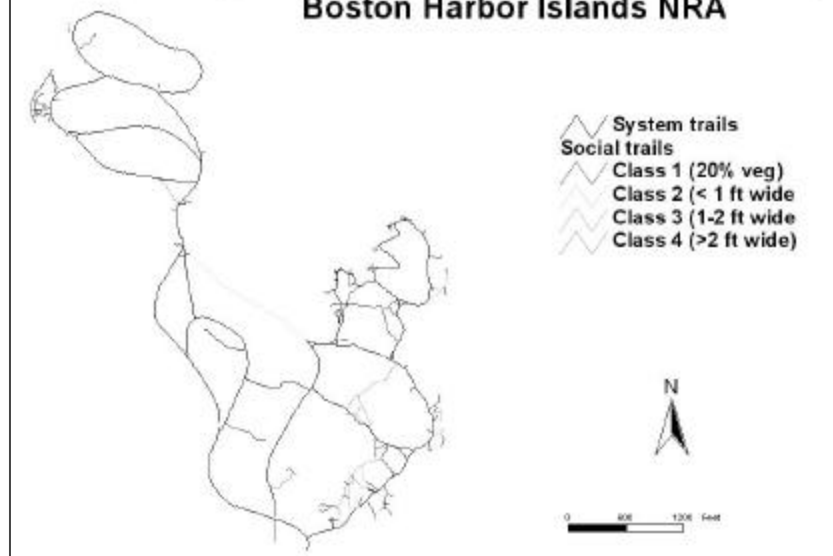
- ◆ Recreation site and trail indicators assessed in 2001
 - Social trails (GPS mapping, conditions)
 - Unofficial recreation sites (GPS, conditions)
 - Conditions of official trails (GPS, conditions)
 - Conditions of official recreation sites (GPS, conditions)
 - Problem segment lengths
 - Site size (disturbed area)
 - Ground cover loss
 - Tree damage
 - Trash
 - Human waste
 - Vandalism

2001 Field Work

- ◆ 22 islands were assessed
 - ◆ Islands with public access
 - ◆ Islands with possible recreational use or impacts
- ◆ System trails
 - ◆ 20 calendar days
 - ◆ 91 trails (19 miles)
- ◆ Recreational sites
 - ◆ Include rest/viewing sites (41), picnic sites (22), official campsites (59) and unofficial campsites (17)
 - ◆ 34 calendar days



System and Social Trails at World's End, Boston Harbor Islands NRA



Field Work in Summer 2002

- ◆ Vegetative and soil quality indicators
 - **Ground cover composition assessed by quadrats and line transects**
 - **Soil texture**
 - **Soil compaction (penetration resistance)**
 - **Soil aggregate stability by slake test**

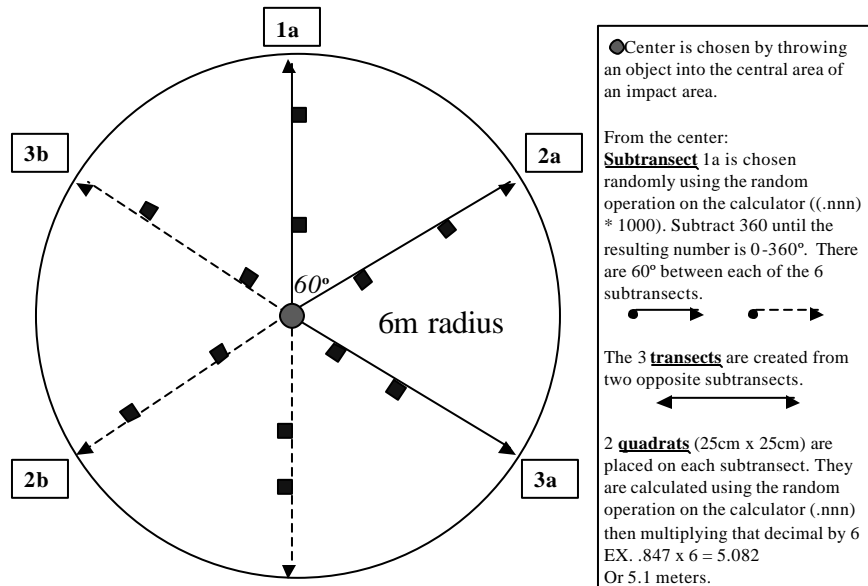


Field Work in Summer 2002

- ◆ June, August and October of 2002
(beginning, middle and end of season)
- ◆ High use and low use sites on Georges, Peddocks and Grape Islands (12 sites)



Sampling Design: 2002 Field Work



Indicator Selection*

◆ Required Criteria

- Low measurement impacts
- Reliable/repeatable measures
- High correlation with visitor use
- Ecological relevancy

◆ Desirable Criteria

- Responds quickly to impacts
- Responds quickly to management
- Easy to measure
- Low natural variability
- Large sampling window
- Cost effective
- Easy to train for monitoring
- Availability of baseline data
- Response over range of conditions

* Adapted from Belnap (1998)

Table 1. Evaluation Matrix of Potential Resource-based Indicators.

SELECTION CRITERIA*	POTENTIAL RESOURCE INDICATORS											
	Access point Easily discuss	Disturbance	Trail conditions	Unofficial disc. sites	Recreation conditions	Proximity to recreation resources	Disturbance comparison Recreation	Disturbance comparison Non-RV	Soil Quality Compaction	Aggregate stability	Human use (RVs)	Modulation
Low management impact	+	+	+	+	+	+	+	+	+	+	+	+
Relatively Resistant	+	+	+	+	+	+	+	+	+	+	0	0
Correlation with use	+	+	+	+	+	0	+	+	+	+	+	+
Ecologically or socially relevant	+	+	+	+	+	+	+	+	+	+	0	0
Respond to impacts	+	+	+	+	+	+	+	+	+	+	+	?
Respond to management	0	0	+	+	+	+	+	+	+	+	+	+
Easy to measure	+	0	+	+	+	0	+	+	+	+	0	-
Low natural variability	+	+	+	+	+	+	-	0	0	0	?	n.a.
Learn something valuable	+	+	+	+	+	+	+	+	+	+	+	+
Cost effective	0	0	0	0	0	0	+	+	+	+	+	+
Easy to train for monitoring	0	0	+	+	+	0	+	+	+	+	0	0
Baseline data	0	0	+	0	+	+	-	-	+	-	-	-
Response over different conditions	+	+	0	+	0	?	+	+	+	+	-	-
Recommended for BOH/VTRP implementation**	✓✓	?	✓	✓✓	✓✓	?	×	✓	✓	×	×	×

* The first 4 criteria are required while the other 9 are desirable criteria. These criteria were adapted from previous VTRP studies (Behr, 1998; Greater Yellowstone Water Use Management Working Group, 1999).

+ = criterion satisfied 0 = criterion partially satisfied (or varies by season/year) - = criterion not satisfied ? = questionable/undecided
n.a. = not applicable

× = not recommended ✓ = recommended ✓✓ = highly recommended ? = questionable/undecided

Recommended Indicators

(1) First-Tier

- ◆ *Density of unofficial or social trails*
- ◆ *Area of disturbance on unofficial recreation sites*
- ◆ *Bare soil exposure on recreation sites*

(2) Second-Tier

- ◆ Eroded trail segments
- ◆ Tree damage at recreation sites
- ◆ Relative soil compaction on recreation sites

Other Possible Indicators

- ◆ Social trail offshoot points
- ◆ Social trail index (STI) - Integrating conditions and frequency
- ◆ Density of social trails in the proximity (50-100m) of habitats of rare, threatened and endangered species
- ◆ Number of unofficial recreation sites in the proximity (50-100m) of habitats of rare, threatened and endangered species
- ◆ Ground cover changes (quadrat method)

Dropped Indicators

- ◆ Paved trail conditions
- ◆ Vandalism
- ◆ Littering/trash
- ◆ Soil aggregate stability
- ◆ Ground cover estimates by line transects

Recommended Standards

Types of Standards

- ◆ Maximum Std.: Most restrictive
- ◆ Minimum Std.: Least restrictive (bottomline)
- ◆ Probabilistic Std.: No more than X% of sites have more than Y amount of impact (i.e., existence of limited number of highly impacts sites/trails are acceptable)

Some Considerations

- ◆ Managed vs. unmanaged use
- ◆ Amount of use (high vs. low use)
- ◆ Sensitivity of resources
- ◆ Soil erosion potential (e.g. = < 30% bare soil)
- ◆ Existing conditions (10% percentile)
- ◆ Possibility for improvement

Work Ahead

- ◆ Data analysis and integration with BOHA GIS databases and the social component
- ◆ Final selection of indicators and associated measures and standards
- ◆ Carrying capacity guidelines (with UVM and BOHA Planning Committee)
- ◆ Monitoring protocols for selected indicators
- ◆ Staff training for monitoring procedures